

What is claimed is:

1. A deflection angle detecting device detecting a deflection angle of a light-deflecting element, the deflection angle detecting device comprising:

a light source radiating light;

5 a path switching plane switching an optical path of part of light radiated from the light source;

a detecting reflection surface placed on an optical path switched by the path switching plane and provided to the light-deflecting element; and

10 a photodetector receiving light reflected by the detecting reflection surface to detect the deflection angle of the light-deflecting element in accordance with the position where the light is received,

wherein a transmission surface with positive power is interposed between the detecting reflection surface and the photodetector.

2. A deflection angle detecting device detecting a deflection angle of a light-deflecting element, the deflection angle detecting device comprising:

a light source radiating light;

a prism constructed with at least three surfaces;

5 a decentered lens constructed with two surfaces;

a detecting reflection surface placed on the optical path of light from the light source, switched through the prism, and provided to the light-deflecting element; and

10 a photodetector receiving light reflected by the detecting reflection surface to detect the deflection angle of the light-deflecting element in accordance with a position where the light is received,

the prism comprising:

a first surface having a function of transmitting incident light from the light source through the prism;

15 a second surface having a function of reflecting light transmitted through the first surface, a function of transmitting light reflected by another optical working surface of the prism so that the light leaves the prism toward the detecting reflection surface, and a function of transmitting incident light from the detecting reflection surface through the prism; and

20 a third surface having a function of reflecting light reflected by the second surface toward the detecting reflection surface and a function of transmitting light transmitted through the second surface toward the photodetector, and

the decentered lens comprising:

a fourth surface provided opposite to the third surface and

25 a fifth surface which is a transmission surface situated between the fourth surface and the photodetector, having positive power.

3. A deflection angle detecting device detecting a deflection angle of a light-deflecting element, the deflection angle detecting device comprising:

a light source radiating light;

a prism constructed with at least four surfaces;

5 a detecting reflection surface placed on an optical path of light from the light source, switched through the prism, and provided to the light-deflecting element; and

a photodetector receiving light reflected by the detecting reflection surface to detect the deflection angle of the light-deflecting element in accordance with a position where the light is received,

10 the prism comprising:

a first surface having a function of transmitting incident light from the light source

through the prism;

a second surface having a function of reflecting light transmitted through the first surface toward the detecting reflection surface and a function of transmitting light trans-
mitted through another optical working surface of the prism to cause the light to emerge
from the prism toward the photodetector;

a third surface having a function of transmitting light reflected by the second surface
so that the light leaves the prism toward the detecting reflection surface; and

a fourth surface having a function of transmitting incident light from the detecting
reflection surface through the prism, and

one of the first surface and the second surface having positive power.

4. A deflection angle detecting device according to claim 1, wherein a prism filled with a medium of a refractive index of 1 or more is placed in an optical path between the light source and the detecting reflection surface.

5. A deflection angle detecting device according to claim 4, wherein a part of an optical path from the detecting reflection surface to the photodetector passes through a part of the prism placed in the optical path between the light source and the detecting reflection surface.

6. A deflection angle detecting device according to claim 5, wherein a second prism including the transmission surface with positive power is interposed between the prism and the photodetector.

7. A deflection angle detecting device according to claim 6, wherein the prism is cemented to the second prism.

8. A deflection angle detecting device according to claim 1, wherein the path switching plane is configured as a beam splitter surface reflecting or transmitting part of light.
9. A deflection angle detecting device according to claim 1, wherein the path switching plane is configured as a polarization beam splitter reflecting or transmitting light in accordance with a polarization state of the light.
10. A deflection angle detecting device according to claim 1, wherein the path switching plane is configured as a holographic surface reflecting or transmitting light in accordance with an angle of incidence or an wavelength of the light.
11. A deflection angle detecting device according to claim 1, wherein the path switching plane is configured as a surface transmitting or totally reflecting light in accordance with an angle of incidence of the light.
12. A deflection angle detecting device according to claim 1, wherein the path switching plane has positive power.
13. A deflection angle detecting device according to claim 12, wherein the path switching plane is configured as a curved surface.
14. A deflection angle detecting device according to claim 12, wherein the path switching plane is configured as a spherical surface.
15. A deflection angle detecting device according to claim 12, wherein the path switching plane is configured as a rotational symmetrical aspherical surface.

16. A deflection angle detecting device according to claim 13, wherein the path switching plane is configured as an irrotational symmetrical surface.

17. A deflection angle detecting device according to claim 1, wherein the path switching plane is configured as a flat surface.

18. A deflection angle detecting device according to claim 4, wherein a surface placed opposite to the detecting reflection surface is provided, the surface combining an entrance surface with a reflection surface.

19. A deflection angle detecting device according to claim 4, wherein a surface placed opposite to the detecting reflection surface is provided, the surface having an internal reflection function and a transmission function.

20. A deflection angle detecting device according to claim 4, wherein a surface placed opposite to the detecting reflection surface is provided, the surface having an internal reflection function with total reflection.

21. A deflection angle detecting device according to claim 4, wherein a surface placed opposite to the detecting reflection surface is provided, the surface being configured as a flat surface.

22. A deflection angle detecting device according to claim 4, wherein a surface placed opposite to the detecting reflection surface is provided, the surface being configured as a curved surface.

23. A deflection angle detecting device according to claim 4, wherein a surface placed opposite to the detecting reflection surface is provided, the surface being configured as a spherical surface.

24. A deflection angle detecting device according to claim 4, wherein a surface placed opposite to the detecting reflection surface is provided, the surface being configured as a rotational symmetrical aspherical surface.

25. A deflection angle detecting device according to claim 4, wherein a surface placed opposite to the detecting reflection surface is provided, the surface being configured as an irrotational symmetrical surface.

26. A deflection angle detecting device according to claim 1, wherein an optical member with positive power is interposed between the light source and the path switching plane.

27. A deflection angle detecting device according to claim 4, wherein an entrance surface of the prism placed opposite to the light source has positive power.

28. A deflection angle detecting device according to claim 1, wherein the transmission surface with positive power is configured as a spherical surface.

29. A deflection angle detecting device according to claim 1, wherein the transmission surface with positive power is configured as a rotational symmetrical aspherical surface.

30. A deflection angle detecting device according to claim 1, wherein the transmission

surface with positive power is configured as an irrotational symmetrical surface.

31. A deflection angle detecting device according to claim 1, wherein the transmission surface with positive power is configured as a Fresnel surface.

32. A deflection angle detecting device according to claim 2, wherein the function of reflecting light of the second surface of the prism is a function of totally reflecting light.

33. A deflection angle detecting device according to claim 2, wherein the third surface of the prism is configured as a half mirror surface.

34. A deflection angle detecting device according to claim 2, wherein the third surface of the prism is configured as a polarization beam splitter surface.

35. A deflection angle detecting device according to claim 2, wherein the third surface of the prism is configured as a diffraction optical surface.

36. A deflection angle detecting device according to claim 2, wherein the third surface of the prism is configured as a holographic optical surface.

37. A deflection angle detecting device according to claim 2, wherein the third surface of the prism is cemented to the fourth surface thereof.

38. A deflection angle detecting device according to claim 2, wherein the first surface of the prism is configured as a surface with positive power.

39. A deflection angle detecting device according to claim 2, wherein at least one of the first surface to fifth surface is configured as a Fresnel surface.

40. A deflection angle detecting device according to claim 3, wherein the function of reflecting light of the second surface of the prism is a function of totally reflecting light.

41. A deflection angle detecting device according to claim 3, wherein the second surface of the prism is configured as a surface with positive power in one of an area having the function of reflecting light and an area having the function of causing the light to emerge from the prism toward the photodetector.

42. A deflection angle detecting device according to claim 3, wherein the first surface of the prism is configured as a surface with positive power.

43. A deflection angle detecting device detecting a deflection angle of a light-deflecting element, the deflection angle detecting device comprising:

a light source for radiating light to the light-deflecting element;

a detecting reflection surface with positive power provided to the light-deflecting element, placed on an optical axis of light radiated from the light source; and

a photodetector receiving light reflected by the detecting reflection surface to detect the deflection angle of the light-deflecting element in accordance with a position where the light is received.

44. A deflection angle detecting device according to claim 43, wherein the detecting reflection surface is decentered with respect to the optical axis of the light radiated from the light source.

45. A deflection angle detecting device according to claim 43, wherein a path switching element switching at least one part of the light radiated from the light source is placed on the optical axis.
46. A deflection angle detecting device according to claim 43, wherein an optical element with positive power is interposed between the light source and the detecting reflection surface.
47. A deflection angle detecting device according to claim 43, wherein an optical element with positive power is interposed between the detecting reflection surface and the photodetector.
48. A deflection angle detecting device according to claim 46 or 47, wherein the optical element with positive power is provided with a rotational symmetrical surface.
49. A deflection angle detecting device according to claim 46 or 47, wherein the optical element with positive power includes a Fresnel lens surface.
50. A deflection angle detecting device according to claim 43, wherein the detecting reflection surface is a front surface mirror reflection surface.
51. A deflection angle detecting device according to claim 43, wherein the detecting reflection surface is a back surface mirror reflection surface configured of a medium with a refractive index of 1 or more.
52. A deflection angle detecting device according to claim 43, wherein the detecting

reflection surface has rotational symmetrical optical power.

53. A deflection angle detecting device according to claim 43, wherein the detecting reflection surface has irrotational symmetrical optical power.

54. A deflection angle detecting device according to claim 43, wherein optical elements with positive powers are interposed in optical paths between the light source and the detecting reflection surface and between the detecting reflection surface and the photodetector, at least one for each optical path.

55. A deflection angle detecting device according to claim 43, wherein an optical element with positive power including a common member is interposed between the light source and the detecting reflection surface and between the detecting reflection surface and the photodetector.

56. A deflection angle detecting device according to claim 55, wherein the detecting reflection surface is provided on a back surface of the optical element with positive power including the common member.

57. A deflection angle detecting device according to claim 54, wherein at least one optical surface of one of the optical elements is configured into an irrotational symmetrical profile.

58. A deflection angle detecting device according to claim 54, wherein at least one optical surface of one of the optical elements has a function of reflecting light.

59. A deflection angle detecting device according to claim 58, wherein the optical surface having the function of reflecting light of one of the optical elements combines a function of reflecting light with a function transmitting light.

60. A deflection angle detecting device according to claim 43, wherein two sets of light-deflecting elements and detecting reflection surfaces are provided and a light beam radiated from the light source is split so that reflection angles of a plurality of light-deflecting elements provided with the detecting reflection surfaces are detected.

61. A deflection angle detecting device according to claim 43, wherein the detecting reflection surface has a reflection surface position detecting means outside an effective diameter.

62. A deflection angle detecting device detecting a deflection angle of a light-deflecting element, the deflection angle detecting device comprising:

a light source for radiating light to the light-deflecting element;

a detecting reflection surface inclined by a preset angle with respect to an optical axis of light radiated from the light source and provided to the light-deflecting element;

a reflected-light condensing optical element with positive power for condensing light reflected by the detecting reflection surface; and

a photodetector receiving light from the reflected-light condensing optical element to detect the deflection angle of the light-deflecting element in accordance with a position where the light is received.

63. A deflection angle detecting device according to claim 62, satisfying the following condition:

$$10^{\circ} < \theta < 70^{\circ}$$

where θ is an angle of incidence of a ray traveling along the optical axis of the light radi-
 5 ated from the light source on the detecting reflection surface.

64. A deflection angle detecting device according to claim 63, wherein at least one of optical working surfaces of the reflected-light condensing optical element is irrotational symmetrical.

65. A deflection angle detecting device according to claim 62, wherein the reflected-light condensing optical element includes a reflection surface with positive power.

66. A deflection angle detecting device according to claim 65, wherein when a ray passing through a center of a position of the photodetector where the light is received, from a center of the light source, is called an axial chief ray, the reflection surface with positive power of the reflected-light condensing optical element is inclined and placed so
 5 that the axial chief ray reflected by the detecting reflection surface is reflected back toward the light source.

67. A deflection angle detecting device according to claim 66, wherein each of optical working surfaces of the reflected-light condensing optical element has functions of an entrance surface and an exit surface, and the reflection surface with positive power is a back surface mirror reflection surface.

68. A deflection angle detecting device according to claim 65, wherein the reflection surface with positive power of the reflected-light condensing optical element is configured as an irrotational symmetrical surface.

69. A deflection angle detecting device according to claim 65, satisfying the following condition:

$$20^{\circ} < \alpha < 110^{\circ}$$

where α is an angle made by an axial chief ray incident on the reflection surface with positive power of the reflected-light condensing optical element with an axial chief ray reflected by the reflection surface.

70. A deflection angle detecting device according to claim 62, wherein the photodetector is placed close to the light source, with a light-receiving surface directed toward an exit side of the light source.

71. A deflection angle detecting device according to claim 62, wherein each of two of optical working surfaces of the reflected-light condensing optical element is configured as a reflection surface.

72. A deflection angle detecting device according to claim 62, wherein each of at least three of optical working surfaces of the reflected-light condensing optical element is configured as a reflection surface.

73. A deflection angle detecting device according to claim 62, wherein an entrance surface and a reflection surface of the reflected-light condensing optical element are configured as a common surface.

74. A deflection angle detecting device according to claim 62, wherein an incident-light condensing optical element with positive power is interposed between the light source and the detecting reflection surface.

75. A deflection angle detecting device according to claim 74, wherein each of optical working surfaces of the incident-light condensing optical element is configured as a rotational symmetrical surface.

76. A deflection angle detecting device according to claim 74, wherein the incident-light condensing optical element is constructed integrally with the reflected-light condensing optical element.

77. A deflection angle detecting device according to any one of claim 1, 43, or 62 wherein the photodetector is a one-dimensional position sensor detector.

78. A deflection angle detecting device according to any one of claim 1, 43, or 62 wherein the photodetector is a two-dimensional position sensor detector.

79. A deflection angle detecting device according to any one of claim 1, 43, or 62 wherein the photodetector has a four-divided light-receiving surface.

80. An optical signal switch system having a deflection angle detecting device detecting a deflection angle of a light-deflecting element and a deflection angle control means controlling the deflection angle of the light-deflecting element through an output from the deflection angle detecting device, the deflection angle detecting device comprising:

a light source radiating light;

a path switching plane switching an optical path of part of light radiated from the light source;

a detecting reflection surface placed on an optical path switched by the path switching

plane and provided to the light-deflecting element; and

a photodetector receiving light reflected by the detecting reflection surface to detect the deflection angle of the light-deflecting element in accordance with the position where the light is received,

wherein a transmission surface with positive power is interposed between the detecting reflection surface and the photodetector.

81. An information record reproducing system having a deflection angle detecting device detecting a deflection angle of a light-deflecting element, the deflection angle detecting device comprising:

a light source radiating light;

a path switching plane switching an optical path of part of light radiated from the light source;

a detecting reflection surface placed on an optical path switched by the path switching plane and provided to the light-deflecting element; and

a photodetector receiving light reflected by the detecting reflection surface to detect the deflection angle of the light-deflecting element in accordance with the position where the light is received,

wherein a transmission surface with positive power is interposed between the detecting reflection surface and the photodetector,

the information record reproducing system including:

a recording medium having a recording surface which allows record or reproduction of an information signal, or both, by radiating light;

a light source radiating a light beam, performing the record or reproduction of the information signal, or both, with respect to the recording medium;

an optical system imaging the light beam on the recording surface of the recording

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medium; and

the light-deflecting element placed in the optical system, deflecting the light beam and having the detecting reflection surface whose inclination angle is changed in association with the deflection angle.

82. A light-deflecting system using a deflection angle detecting device detecting a deflection angle of a light-deflecting element, the deflection angle detecting device comprising:

a light source radiating light;

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a path switching plane switching an optical path of part of light radiated from the light source;

a detecting reflection surface placed on an optical path switched by the path switching plane and provided to the light-deflecting element; and

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a photodetector receiving light reflected by the detecting reflection surface to detect the deflection angle of the light-deflecting element in accordance with the position where the light is received,

wherein a transmission surface with positive power is interposed between the detecting reflection surface and the photodetector.

83. An optical signal switch system having a deflection angle detecting device detecting a deflection angle of a light-deflecting element and a deflection angle control means controlling the deflection angle of the light-deflecting element through an output from the deflection angle detecting device, the deflection angle detecting device comprising:

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a light source for radiating light to the light-deflecting element;

a detecting reflection surface with positive power provided to the light-deflecting ele-

ment, placed on an optical axis of light radiated form the light source; and

10 a photodetector receiving light reflected by the detecting reflection surface to detect the deflection angle of the light-deflecting element in accordance with a position where the light is received.

84. An information record reproducing system having a deflection angle detecting device detecting a deflection angle of a light-deflecting element, the deflection angle detecting device comprising:

a light source for radiating light to the light-deflecting element;

5 a detecting reflection surface with positive power provided to the light-deflecting element, placed on an optical axis of light radiated form the light source; and

a photodetector receiving light reflected by the detecting reflection surface to detect the deflection angle of the light-deflecting element in accordance with a position where the light is received.

85. A light-deflecting system using a deflection angle detecting device detecting a deflection angle of a light-deflecting element, the deflection angle detecting device comprising:

a light source for radiating light to the light-deflecting element;

5 a detecting reflection surface with positive power provided to the light-deflecting element, placed on an optical axis of light radiated form the light source; and

a photodetector receiving light reflected by the detecting reflection surface to detect the deflection angle of the light-deflecting element in accordance with a position where the light is received.

86. An optical signal switch system having a deflection angle detecting device de-

detecting a deflection angle of a light-deflecting element and a deflection angle control means controlling the deflection angle of the light-deflecting element through an output from the deflection angle detecting device, the deflection angle detecting device comprising:

a light source for radiating light to the light-deflecting element;

a detecting reflection surface inclined by a preset angle with respect to an optical axis of light radiated from the light source and provided to the light-deflecting element;

a reflected-light condensing optical element with positive power for condensing light reflected by the detecting reflection surface; and

a photodetector receiving light from the reflected-light condensing optical element to detect the deflection angle of the light-deflecting element in accordance with a position where the light is received.

87. An information record reproducing system having a deflection angle detecting device detecting a deflection angle of a light-deflecting element, the deflection angle detecting device comprising:

a light source for radiating light to the light-deflecting element;

a detecting reflection surface inclined by a preset angle with respect to an optical axis of light radiated from the light source and provided to the light-deflecting element;

a reflected-light condensing optical element with positive power for condensing light reflected by the detecting reflection surface; and

a photodetector receiving light from the reflected-light condensing optical element to detect the deflection angle of the light-deflecting element in accordance with a position where the light is received.

88. A light-deflecting system using a deflection angle detecting device detecting a de-

deflection angle of a light-deflecting element, the deflection angle detecting device comprising:

a light source for radiating light to the light-deflecting element;

5 a detecting reflection surface inclined by a preset angle with respect to an optical axis of light radiated from the light source and provided to the light-deflecting element;

a reflected-light condensing optical element with positive power for condensing light reflected by the detecting reflection surface; and

10 a photodetector receiving light from the reflected-light condensing optical element to detect the deflection angle of the light-deflecting element in accordance with a position where the light is received.